

**GARZA**

**Design of a hydro-electric plant on  
the Quebrada River at Topia, Mexico**

**Electrical Engineering**

**B. S.**

**1910**

UNIVERSITY OF ILLINOIS  
LIBRARY

Class

1910

Book

G19

Volume

Mr10-20M





DESIGN OF A HYDRO-ELECTRIC PLANT  
ON THE QUEBRADA RIVER AT  
TOPIA, MEXICO

*826  
78 m/d*

BY

JUAN IGNACIO GARZA

---

THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

ELECTRICAL ENGINEERING

---

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED JUNE, 1910 *n*



1970  
G19  
32 Fil. 1919  
1 -  
UNIVERSITY OF ILLINOIS

June 1 1900

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

JUAN IGNACIO GARZA

ENTITLED DESIGN OF A HYDRO-ELECTRIC PLANT ON THE QUEBRADA

RIVER AT TOPIA, MEXICO

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Electrical Engineering

*Edw. H. Walto.*

Instructor in Charge

APPROVED:

*Emmett Berg*


HEAD OF DEPARTMENT OF ELECTRICAL ENGINEERING

168690



-:-CONTENTS-:-

Location.....	1
Resources.....	1
Site of Power Plant.....	1
Titles.....	2
Consumption of Power.....	2
Flow of Water.....	2
Reservoir.....	4
Power Plant.....	4
Turbines.....	5
Generators.....	5
Exciters.....	6
Switch board.....	6



Digitized by the Internet Archive  
in 2016

<https://archive.org/details/designofhydroele00garz>

## REPORT ON THE PROPOSED LIGHT AND POWER PLANT

"LA ILUCION", TOPIA, DURANGO, MEXICO.

### Location:

Topia is the county seat of "El Partido de Tamazula" in the state of Durango, Mexico. Topia lacks every facility of transportation; it has neither wagon roads nor railroads, the only means of transportation being by mule back. The nearest railroad station that can be reached is Tepehuanes, at a distance of 100 miles.

### Resources:

The two principal resources of Topia and surrounding territory are mines and timber. Pine, oak and spruce trees cover the plateau of the Sierra Madre for an area of nearly 100 miles around Topia. The trees will average about twenty inches in diameter and from eighty to one hundred feet in height. It is estimated that it would average about 5,000 board feet of timber per acre.

The mines of Topia and surrounding territory are, so to speak, just beginning to be developed. Topia ores are chiefly lead and silver, carrying some gold and copper.

### Site of Power Plant:

Plate #1 shows the location of the site for the proposed power plant as being about two miles N. E. of the town of Topia. The intake of the water would be about 5000 feet N. E. from the power plant, the water being conducted to the pipe line by about 330 feet of tunnel and 1800 feet of ditch and flumes.

A profile of the proposed pipe line, tunnel and ditch is given in plate #2 and from the scale of the profile it will be seen that the vertical distance between the intake and power house level is about 1600.



Due to the very favorable topographical features of the site, a ditch can very easily be constructed from the water intake to the tunnel mouth, along the side-hill. The tunnel will serve a two-fold purpose; it will be used to anchor the pipe firmly and to serve as a reservoir to insure sufficient delivery of water at all times to the pipe. From the tunnel, the water will be delivered to the power plant by 10 and 8 inch pipes.

#### Titles:

The title of concession for this water power is held by Mr. Ramon Espinosa; the adjacent land is called "La Ilucion" and is owned by him. Furthermore, there are franchises exempting from taxation for a certain period of time, and the importation of machinery and equipment free of duty.

#### Consumption of Power:

Lighting Purposes:- A canvass was made of the residences of Topia and it is estimated that about 1000 incandescent lamps will be required; about 200 more will be used for the mines. The city council has advised that it will take 12 arc lamps.

Power Purposes:- The Perla Mining Co. have advised that they were ready to sign a long time contract for 50 horse power per annum as a minimum; The Topia Mining Co. have estimated they will require at least 50 horse power; Salvador Lopez Sues would take from 10 to 20 horse power. Aside from the above there are a number of small enterprises, such as saw mills, brick presses, ice plant, corn mills, printing presses, etc., that would consume small amounts of power.

#### Flow of Water:

In 1907 a series of measurements of water were carried on



from May 19 to July 2, the records of which may be seen in Plate #3. The year of 1907 was the dryest of a score of years and the measurements were taken during the dryest season of the year; so that these figures are very conservative and show the worst possible condition.

Referring to Plate #3, it may be seen that the average flow of water from May 19 to July 2, 1907, was a trifle over 31 cubic feet per minute. The decrease per day during this period of time was 0.397 cubic feet per minute. On March 30, 1908, some other measurements were made and the volume of water was found to be 136.16 cubic feet per minute, and assuming that the decrease will be in the same ratio as for the period of March 30 to May 20, 1907, the volume of water on May 20, 1908 should have been 177.15 cubic feet per minute against 46 cubic feet per minute in May 20, 1907.

The year 1908 was a normal year but provision has been made for the dryest year and for the dryest season of the year, 1907, as I have said before was an exceptionally dry year, and consequently all this data is conservative. The low water season for the Quebrada River is from January to June and when there are the usual winter rains, the low season is retarded to March or April. The water has to be reserved only for the months of April, May and June, since even with low water, the quantity of water required is less than that of the stream in January, February or March.

From June to January, the volume of water is from 2000 to 3000 cubic feet per minute, and consequently, with proper reservoir, the power that can be obtained is far more than that required



### Reservoir:

Calculating on a head of 1600 feet and a capacity of the plant 300 H. P. with an efficiency of 75%, there are required 131 cubic feet per minute or 100 cubic feet more than it was after April 1, 1907. Allowing that this amount of water has to be reserved for three months, April, May and June, and adding 20% loss for evaporation and leakage, 580,000 cubic yards of water would be needed to be provided for by storage or a block of water 20 feet deep and 900 feet square.

About 2 miles from the proposed site for the power plant, there is a site which has been a lake, and which, by constructing a dam 500 feet long, could be made to store several times the amount of water required for three months.

### Power Plant:

The power plant is a 36'x53' stone and adobe structure, having an inside elevation of 20'. The turbine room is 15'x 48' and occupies the south side of the building, along side of the river. The number of dynamos is three and they are directly connected to the turbines.

Besides the turbine room, the plant has a tool room, 10.5' x 11', a room for the engineer and a gallery for the protective apparatus. Due to the fact that the plant is located no less than two miles from Topia, and connected only by a poor road, it was thought that the engineer should have a living room in the plant. The plant is lighted from the exciter bus bars by ten 32 candle power incandescent lamps. These lamps are supported from the wall by 2'6" brackets. Eight windows 8'x 5' will give plenty of light during day time.



### Turbines:

The turbines are three in number, two 120 H. P. and one 60 H. P., of the tangential type. The effective head being about 1600 feet and the effective diameter of the runner 6 feet, the most efficient speed is about 450 R. P. M. The 120 H. P. turbines have a jet of .375 square inch when working at full load, but it may be adjusted so as to run at best efficiency and required speed from half load to one and one quarter load by increasing or decreasing the size of the jet. The maximum load to be carried is 150 H. P. with a jet of half square inch in cross section.

Each unit-turbine and generator is supported by two 15"x 18" oil bearings about six feet from each and placed at both sides of the generator. Each unit occupies a floor space of 9'x 13'.

Due to the fact that all the freight has to be carried on mule back, no single piece may weigh more than 250 or 300 pounds. The runner is made of a single steel disk, weighing about 240 pounds, and the shaft is hollow and weighs about 310 pounds. No especial masonry was provided to discharge the water from the turbines, an 8" pipe being used because of the small amount of water used.

### Generators:

The speed of the turbine being about 450 or 460 R. P. M. a generator with 16 poles will give a frequency of 60 cycles. The next thing to be considered was whether a machine with stationary armature or stationary field could be obtained cheaper, and which one would be more easily repaired, no single piece weighing more than 300 pounds. It was decided to have generators of the revolv-



ing field type, the armature having to be wound in the plant at the time of erecting the machine.

The power as said before, is going to be distributed to an average of two miles and as the best practice is to have 1000 volts per mile, the voltage of distribution was decided to be 2300 volts, the generators being wound for that voltage so that no step up transformers are required. The system is three phase.

#### Exciters:

Two 6 K. W. 110 volts machines, arranged to belt to any alternator, are used to excite the fields and for the lighting of the plant. As may be seen from the plan of the plant, each exciter can be belted to either the 60 H. P. turbine or to either of the 120 H. P. units by means of a clutch. It would have been better to have the exciters directly connected to a turbine, but due to the high spouting velocity of the water this would have a jet .02 square inch and it is doubtful if such a turbine will have a good efficiency and at any rate, it would have been very uneconomical, due to the first high cost of the turbine and complication in pipe line. Each unit runs at 600 R. P. M. and has four poles.

#### Switch-board:

The switch-board is composed of five 65"x 24"x 2" panels.

Panel #1 is reserved for the two exciters; it contains:

- 2 Ammeters,
- 1 Voltmeter,
- 2 Field Rheostats,
- 1 Pilot lamp,
- 2 Three pole knife switches,
- 1 Voltmeter plug, and
- 2 Voltmeter receptacles.



The panel is designed to operate the two exciters in multiple. The voltmeter may be used with either machine.

Each generator has its own panel with the following instruments:

- 3 Ammeters,
- 1 Three-pole remote control oil switch,
- 2 Field plugs,
- 1 Rheostat,
- 1 Synchronizing socket and plug,
- 1 Voltmeter receptacle,
- 1 Switch board transformer.

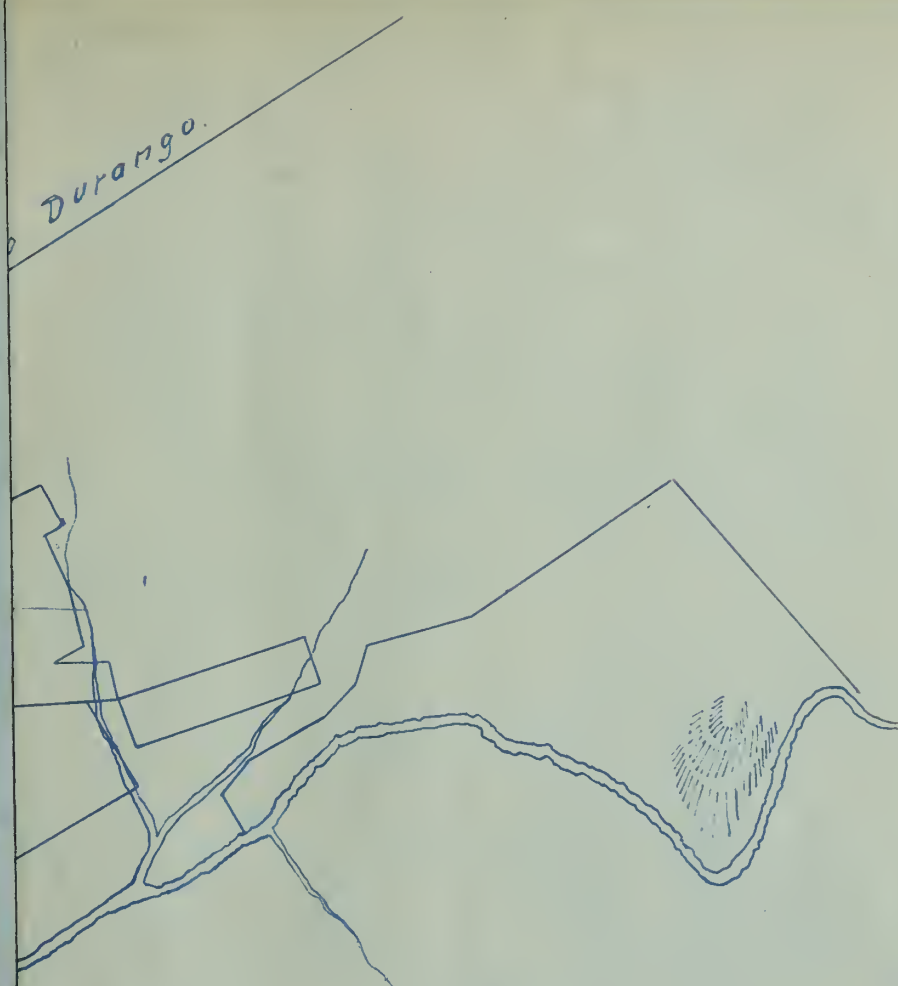
In addition to the above instruments, the panel for the small generator will have,

- 1 Ground detector receptacle and plug,
- 1 Ground detector push button,
- 1 Synchronizing lamp,
- 1 Synchronizing receptacle and plug,
- 3 Switch board transformers,
- 3 Transformer fuse blocks.

An A. C. voltmeter will be located above the switch board so that synchronizing may conveniently be done.

The fifth panel will contain the three outgoing circuits switches to light the plant. Each one of the outgoing circuits has a three pole remote control double break plunger switch, with an overload release. Back of the switch board and just before the lines leave the building, lighting arresters and choking coils are provided as a protective necessity. No high potential conductors are in the switch board so as to avoid all danger.





MAP  
SHOWING LOCATION  
OF THE  
POSED ELECTRIC POWER PLANT  
TRANSMISSION LINES  
AND THE  
TOPIA MINING COMPANIES

STATE OF DURANGO, MEXICO.

J. LAWRENCE

J. I. GARZA.

C.E.

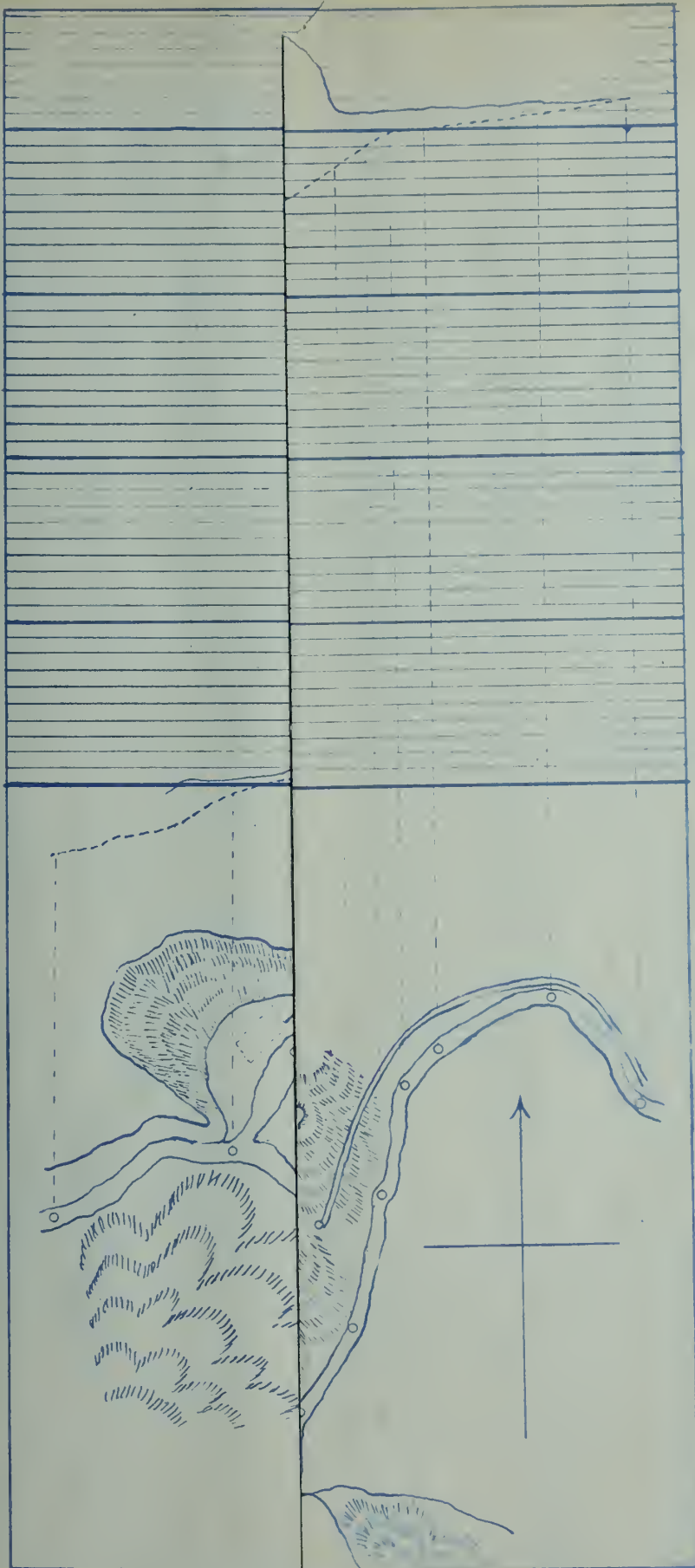
E.E.

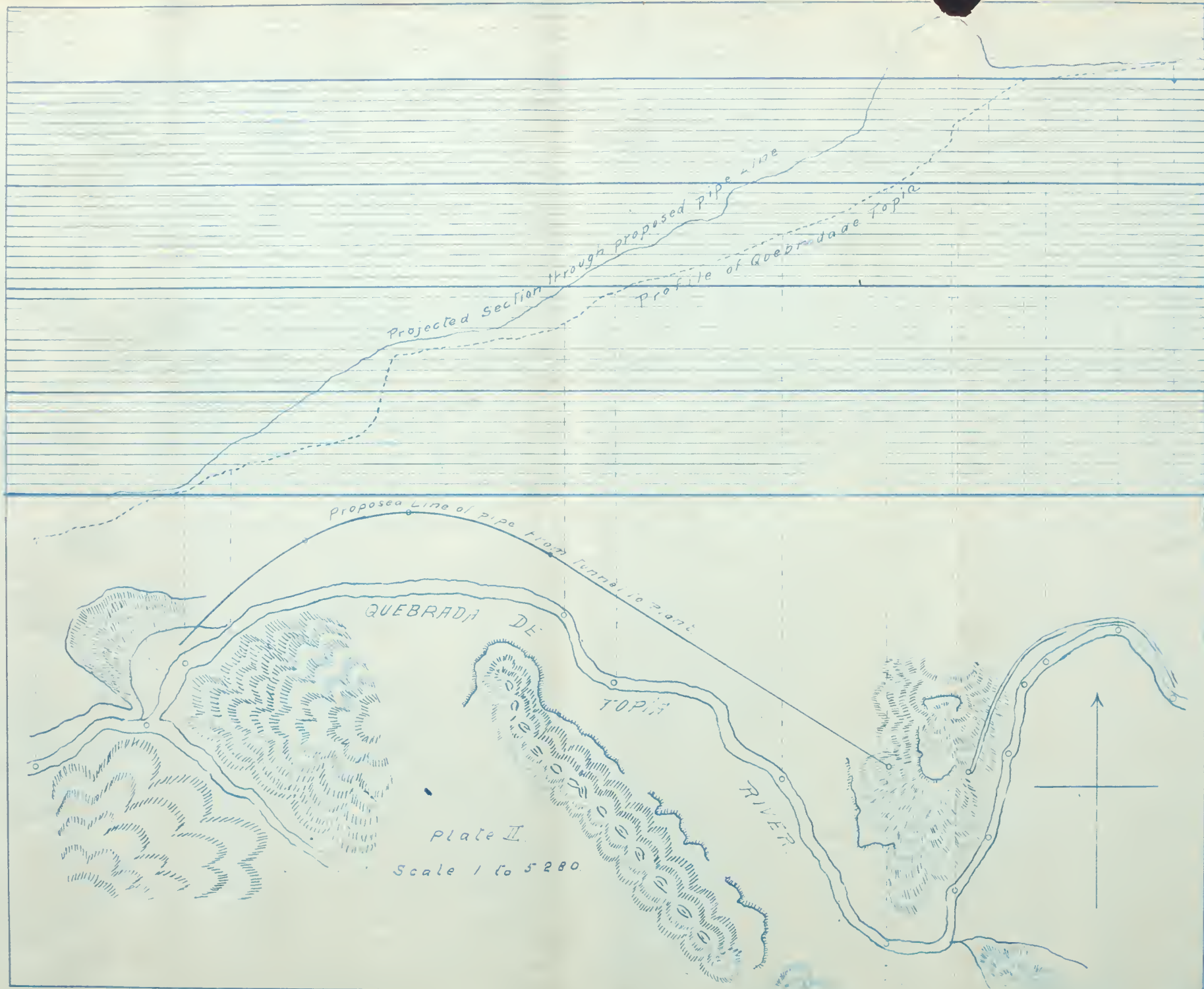
Scale 1 to 15,000

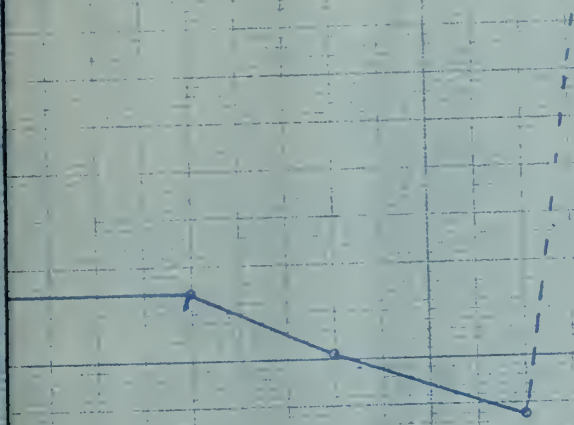
PLATE I.



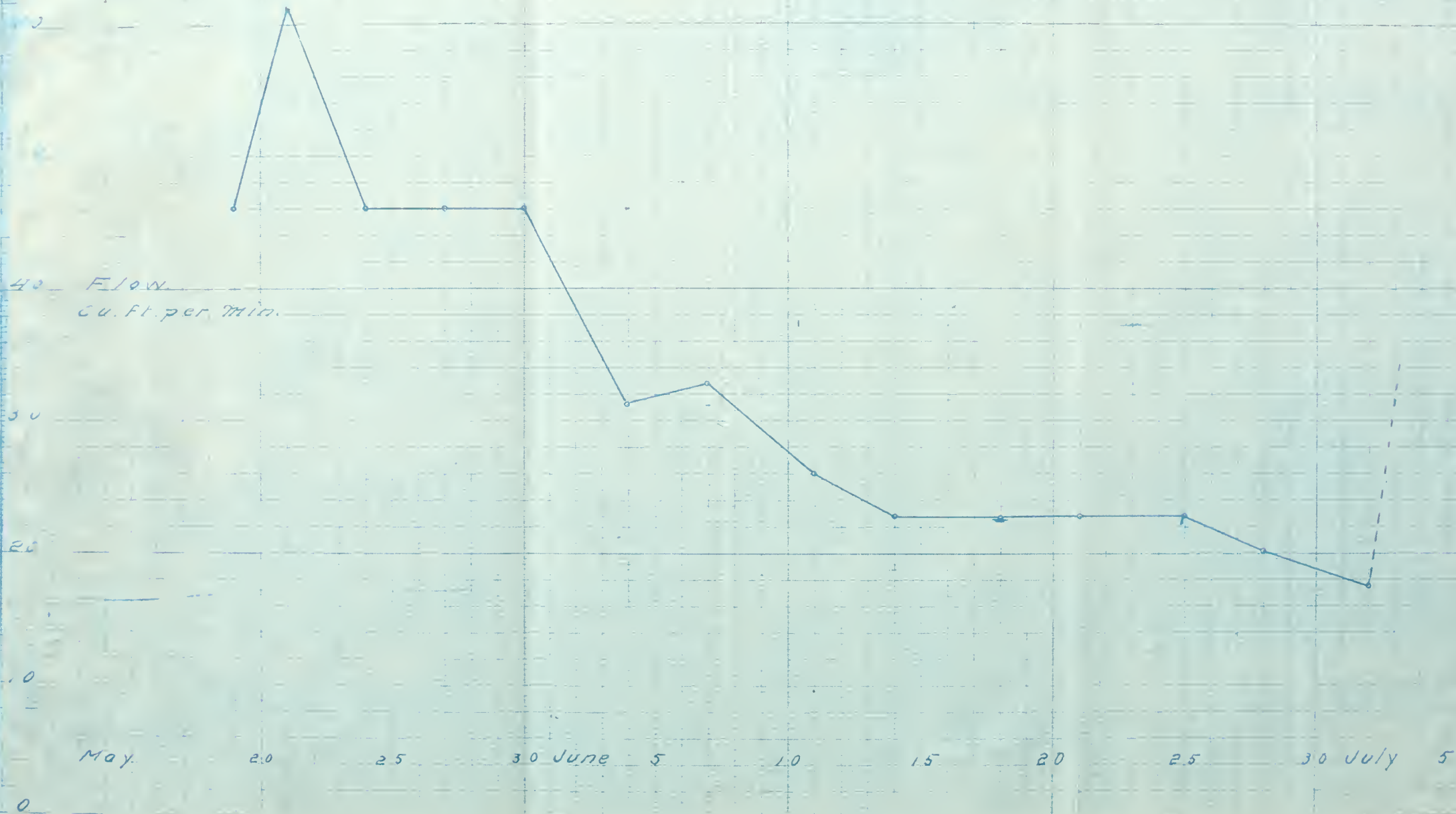
MAP  
SHOWING LOCATION  
OF THE  
PROPOSED ELECTRIC POWER PLANT  
TRANSMISSION LINES  
AND THE  
TOPIA MINING COMPANIES  
STATE OF DURANGO, MEXICO.  
L. J. LAWRENCE J. I. GARZA.  
C.E. Scale 1 to 15000 E.E.  
PLATE I.

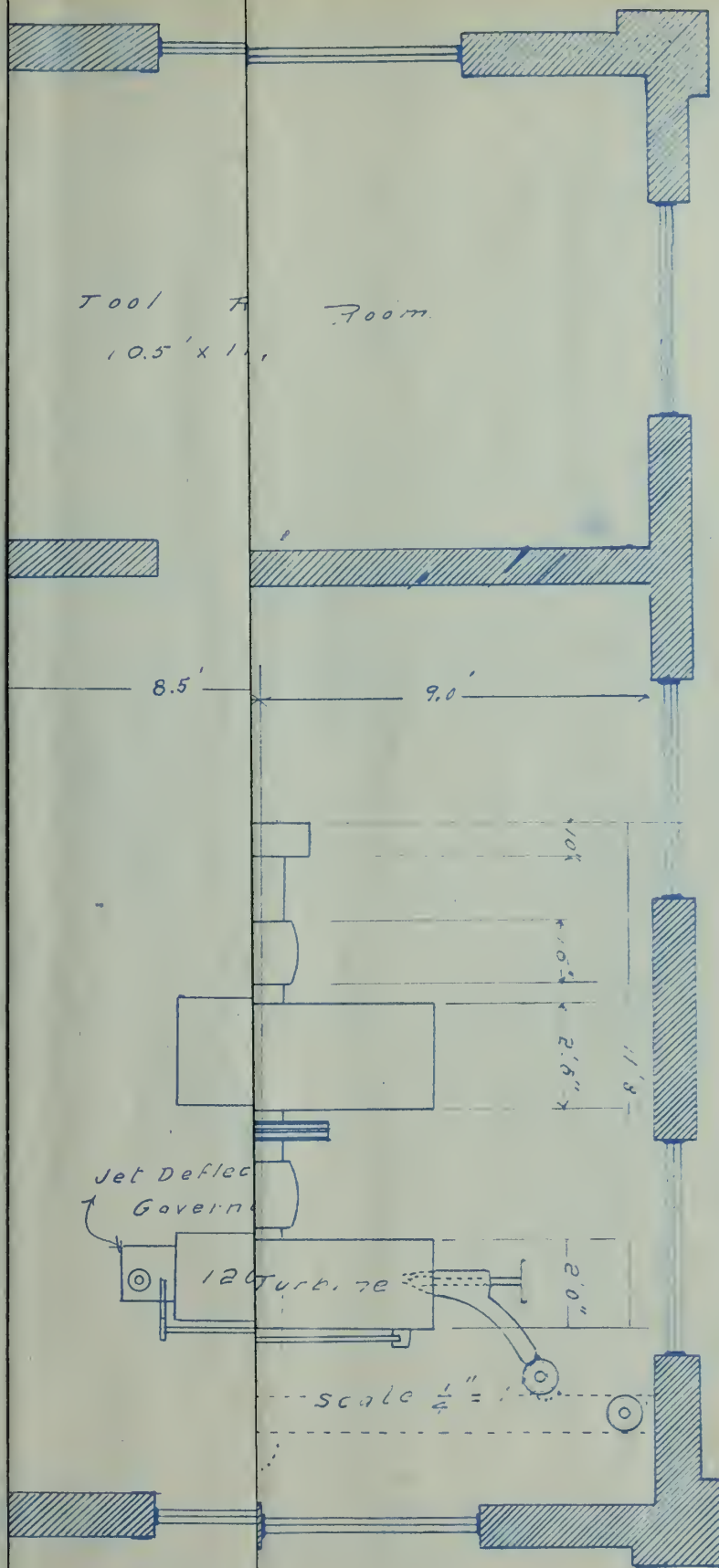


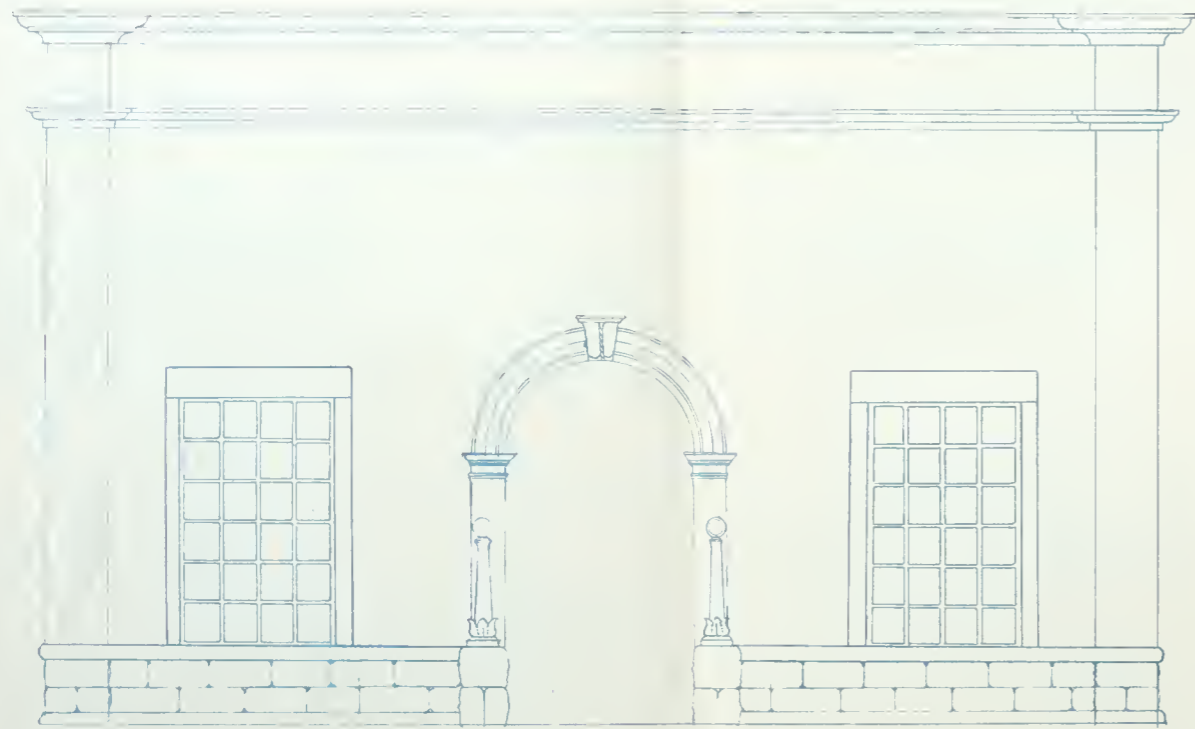




25 30 July 5

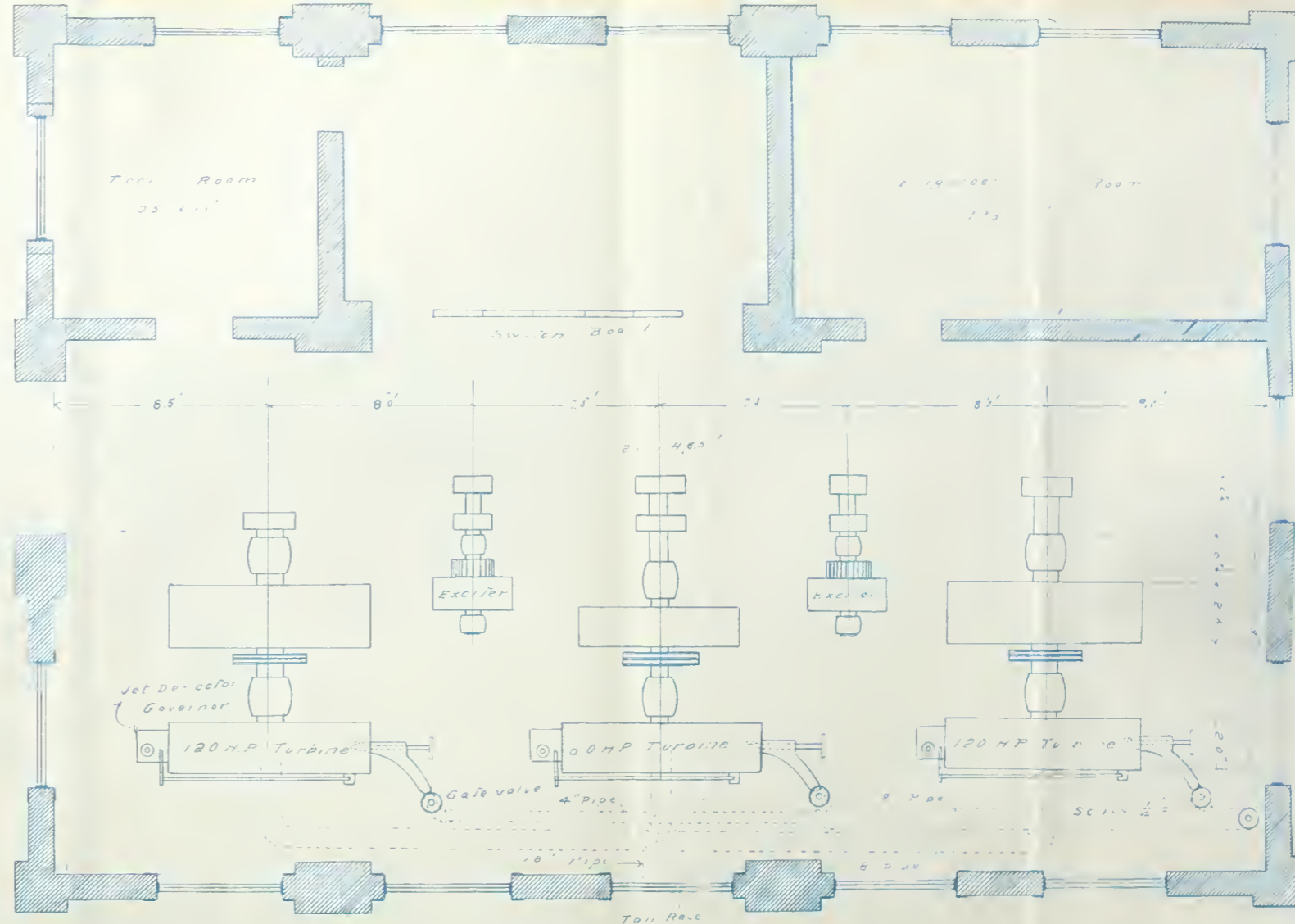


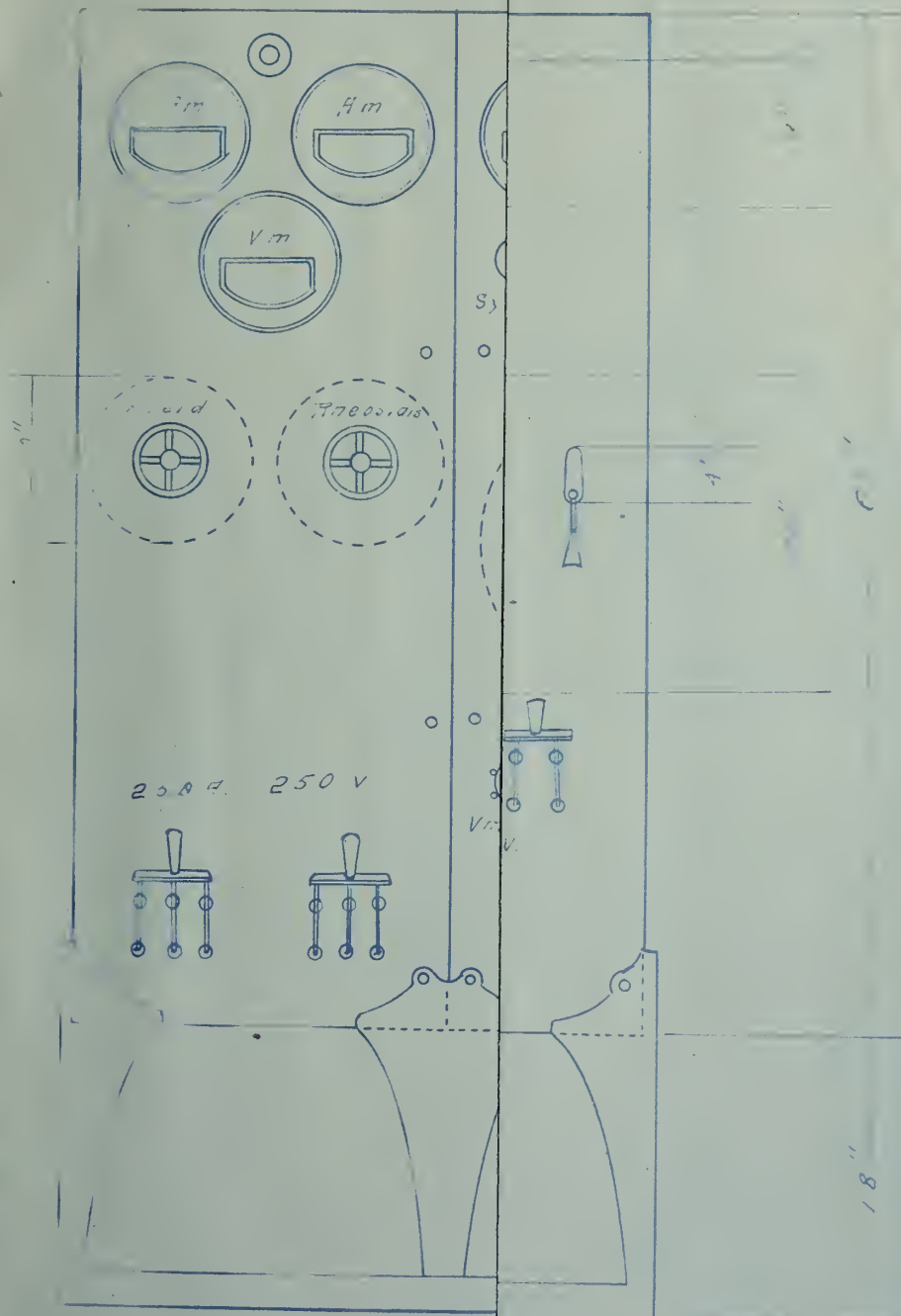


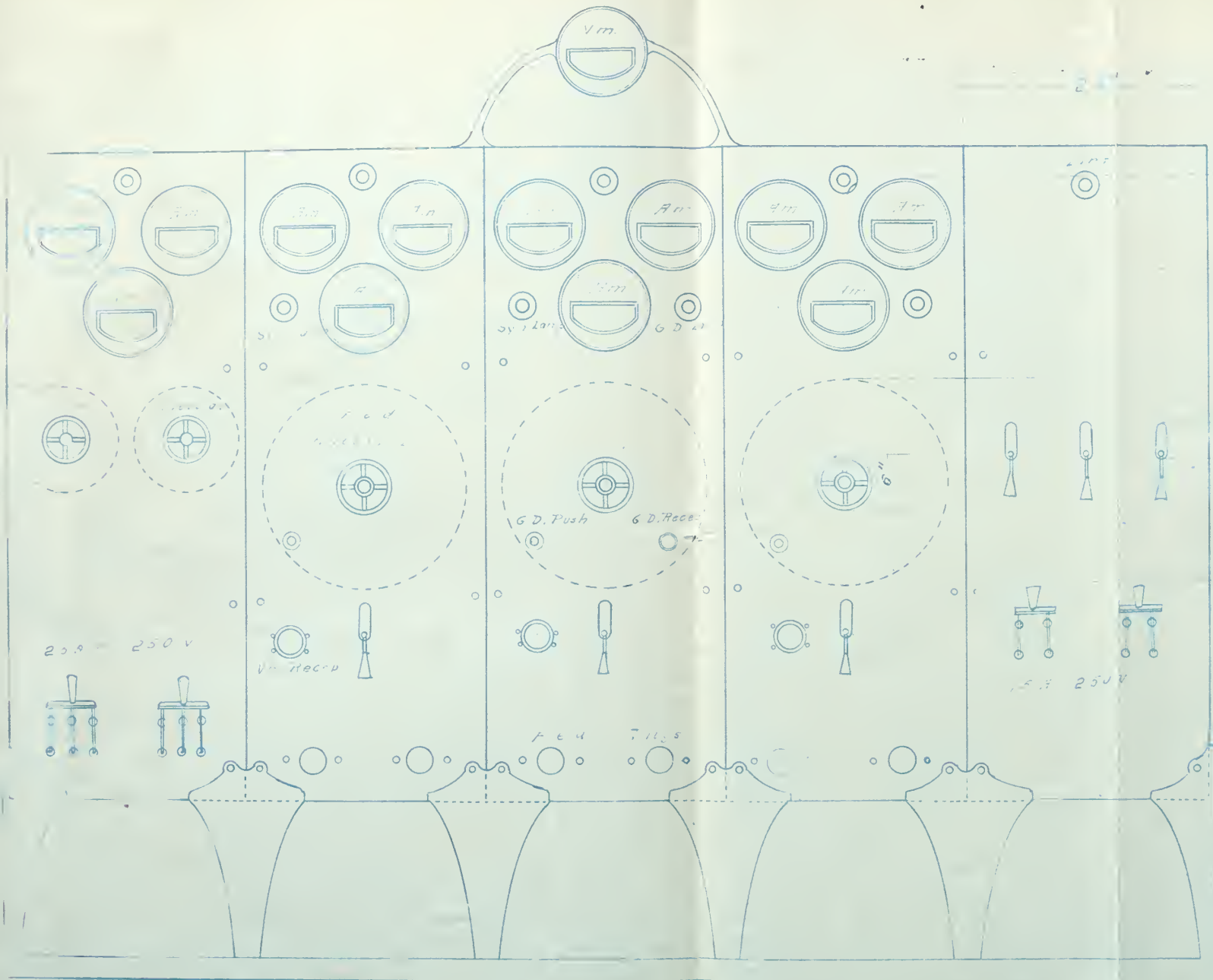


Front elevation

Scale  $\frac{1}{4}'' = 1 \text{ foot}$









UNIVERSITY OF ILLINOIS-URBANA



3 0112 082196483